IV. PRECOAT FILTRATION

A. Description of Unit

Precoat filtration systems employ septum which support the filter medium or filter aid and conduct the filtrate to a collection manifold. Filter media can vary according to the filtration needs and the feed stream chemistry. Diatomaceous earth or perlite are generally used as the filter aid. The cycle consists of three steps; precoat application, filtration of water, and removal of the spent filter cake. Precoating consists of the application of a thin layer, approximately 1.5 to 3 mm (0.06 to 0.12 inch), of the filter media to the septum prior to introducing the feed to the system. This thickness can be achieved by application of approximately 500g to 1Kg of diatomite or perlite per square meter of septum (0.10- 0.20 lb/ft^2). This precoat serves to protect the filter septa from blinding caused by the filtrate and also serves to bridge the larger septa pores. This bridging reduces the size of filtrate particles able to be removed from the feed stream.

The process common to all types of filtration processes in general, depends on forcing a particulate laden liquid or feed stream through a filter fabric or media of predetermined pore size. The driving force behind the feed stream can be either gravity, pressure or vacuum. Suspended particles in the feed stream are trapped on the surface of the filter media while the clarified liquid phase passes through the filter. Precoat filtration uses this basic technique and adds an additional step. The selected filter medium is coated with a thin layer of filter aid or precoat. This precoat material is typically diatomaceous earth, volcanic sand, cellulose or carbon. Whatever the precoat used the purpose is the same; the precoat cake extends the filter operating cycle by preventing the pores of the filter fabric from being blinded by the buildup of a layer of suspended solids in the feed stream. The filter aid also serves to improve the performance of the filter fabric because the large internal surface area of the precoat increases the available area for particle removal.

Due to the hydraulic compression of the filtered solids on the precoat, additional filter media (body feed) is added during the filtration cycle. This continuous addition of body feed during filtration causes a cake build up consisting of solids from the feed stream and porous filter aid particles. The result of the continuous body feed is a greatly extended filter cycle. As an estimate, body feed should be added at a rate of twice the solids level being removed, although the actual addition rate should be

determined by pilot tests or at system start-up. It must be emphasized that the body feed must not be interrupted for any length of time to avoid the build up of an impermeable layer of solids from the feed stream on the media support system.

Precoat filters may operate as pressure filters or vacuum filters. The most common types of precoat filters used for water filtration are vertical leaf filters and cylindrical element filters. See Figure A-15 for a schematic of a typical horizontal plate precoat filter system.

B. Media

1. Mechanism of Operation

As solids are captured by a filter septum, they tend to plug the flow channels through the filter. This results in an increase in pressure drop across the filter and a reduction in filter throughput and filter life cycle. A precoat media enhances filtration by a mechanical straining action. A material such as diatomaceous earth, with its large internal surface area and diverse pore structure, dramatically increases the channels available for liquid flow through the filter cake. This leads to an increased filter cycle and throughput.

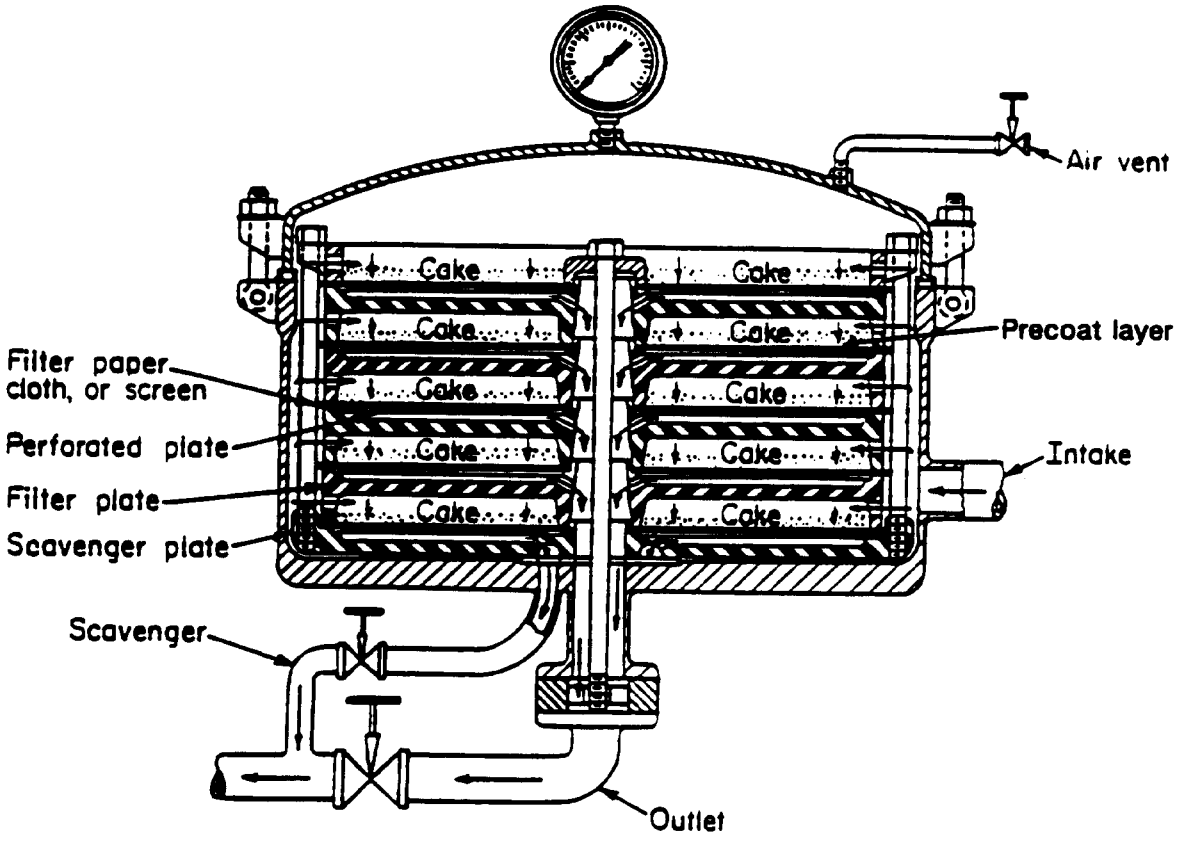
2. Type of Filter Aid Media

Commercially important filter aids are diatomaceous earth, perlite, cellulose and carbon.

Diatomaceous earth - A silica rich (typical 88~) deposit made up of the skeletal remains of prehistoric single cell organisms called diatoms. These diatoms have a unique internal pore structure and geometry which results in a large internal surface for liquid flow. Since there are many different types of diatomaceous earth, there is a wide range of filter aids available, each sized to remove a different particle diameter or range of particle diameters from a feed stream.

Perlite - A natural volcanic glass similar to obsidian. The "raw" perlite is heated to form a fluffy lightweight aggregate. Perlite has a lower bulk density and is more sensitive to extremes in pH than diatomaceous earth. Manufacturers can provide perlite filter aids in a wide range of permeability.

Cellulose - Wood pulp ground to provide different pore sizes. Since cellulose is a relatively compressible material, it is reserved for applications where silica and mineral based materials can not be tolerated.



SOURCE: PERRY'S CHEMICAL ENGINEERING HANDBOOK, SIXTH EDITION

FIGURE A-15. SCHEMATIC OF A TYPICAL PRECOAT HORIZONTAL PLATE FILTER

Carbon - Powdered carbon typically from coal or a vegetable source such as wood or coconut. Carbon is used as a precoat media when removal of dissolved contaminants and odor and taste causing materials is of more importance than removal of suspended solids.

The designer is advised to contact the filtration vendor with data on the process stream to be treated prior to specifying a particular precoat filter aid. Filter aids and their properties are typically proprietary information. The vendors will recommend the appropriate filter aid for the specific equipment and process feed stream based on their operating experience and laboratory testing. However, the following table presents some chemical compatibility information to guide the designer in selecting the proper type of filter aid.

Diatomaceous Earth	**Slight solubility in weak acidic and basic solutions.**
Perlite	**Higher solubility in acidic and basic solutions than diatomaceous earth. Yield highly compressible cakes.**
Cellulose	**High resistance to most chemicals. Insoluble in weak acidic feed streams, slight solubility in basic solutions.**
Carbon	**High resistance to most including caustics.**

3. Configuration

Precoat filters require a precoat mix tank, a body feed mix tank along with the necessary pumps, piping and valving to introduce the filter aid slurry into the feed stream. Materials of construction should be compatible with system fluids and be corrosion resistant. Carbon steel is suitable for process streams with a pH value around the neutral range. Caustic, acidic, or saline process streams or streams containing acidic ferric chloride require equipment and piping constructed of stainless steel, or high nickel alloys such as Inconel or Hastelby. Bell recommends system piping and associated valves and fittings should be sized to maintain liquid velocity below 2 m/s (6.5 feet per second) and in cases where filter aid must be kept in suspension above 1 m/s (3 feet per second) to prevent settling in the lines (Bell, 1962). Bell also recommends that total head loss across the filter from inlet to outlet should not exceed 1

meter (3 feet) of water after correcting for differences in elevation.

A major consideration in precoat filter design is access to filter internals for ease of inspection and cleaning. Ease of access is critical since all filter systems require periodic inspection, maintenance and cleaning. The system designer should be very attentive to construction details concerning cleaning and inspection ports and access points to system internals.

The use of precoat filter aids is cost effective with this type of filter system when the concentration of feed particles is less than 1000 mg/L (regardless of the TSS particle in question). At solids loading above this concentration, the cost of filter aid may become prohibitive (Schweitzer, P. A., Handbook of Separation Techniques for Chemical Engineers, p. 4-12, 1979). In cases where the feed stream has solids concentrations greater than 1000 mg/L, the use of rotary vacuum filter systems is recommended over a batch type systems.

C. Filter Aid Media Support System

The filter aid media is supported by a wide range of materials including; cloth (synthetic or natural materials), sintered plate, porous ceramic, polypropylene or wire screen. Selection of materials depends on the following:

- Chemical properties of the process fluids that will be in contact with the filter internals;
- Minimum flow resistance to filtrate;
- High mechanical strength and wear resistance;
- Resistance to blinding;
- Good cake removal;
- Cost; and
- Ability to support the selected filter aid.

Tables A-9 and A-10 list the characteristics of various filter materials including their chemical resistance properties. The designer should use these tables only as a guide. Filter equipment manufacturers should be consulted and, if appropriate, pilot studies should be conducted to aid in materials selection.

D. Advantages/Disadvantages

Precoat filters generally have minimum space requirements, low capital investment and a decreased need for extensive pretreatment. Because of the high cost of filter aid, precoat filters are not cost effective treating feed streams containing in excess of 1000mg/L TSS. When feed streams are encountered with solids loadings above l000mg/L the designer is advised to consider a rotary vacuum system or, if appropriate, a flocculation/precipitation system.

Precoat filter systems are generally used in the chemical processing and pharmaceutical industry to batch filter a product or process intermediate.

E. Reference. See Appendix D.